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NASA TECH BRIEF

Brazing Method Produces Solid-Solution Bond Between Refractory Metals

The problem: Bonding two refractory metals, such as tungsten and molybdenum, by brazing at as low a temperature as possible to minimize distortion and avoid excessive grain growth in the metals, as well as to simplify processing.

The solution: Brazing by diffusion-controlled formation of a molten-alloy intermediate phase which has a lower melting point than either of the metals to be bonded.

How it's done: In order to braze two metals by this diffusion-bonding method, it is necessary to select an interface metal that forms intermediate low-melting eutectics or solid solutions with the metals to be brazed. Nickel, for example, has been found to be an appropriate interface metal for diffusion bonding of tungsten and molybdenum.

The machined mating surfaces of the tungsten and molybdenum to be joined are lapped to a high finish with diamond lapping compounds, using 0.25-micron diamond powder in the last stage. The finished surfaces are then cleaned and vapor-plated with nickel to a thickness of 1 to 2 angstroms. The plated surfaces are brought into intimate contact in a suitable fixture, and the entire assembly is placed in a reducing atmosphere (hydrogen) in a furnace at 1525°C for a period of 8 to 12 hours. At the end of the bonding process, the assembly is removed from the furnace and cooled to room temperature.

At 1525°C, tungsten and molybdenum form low-melting eutectics with nickel. Consequently, a tungsten–molybdenum–nickel liquid forms at the interface when the assembly is brought to this temperature. During the heating period, the liquid diffuses from the interface into the tungsten and molybdenum by lattice and grain-boundary mechanisms, leaving a strong interface bond consisting of a solid tungsten–molybdenum alloy.

Notes:

1. Because the growth rate of the liquid region is temperature dependent, it is very important that the temperature not be higher than necessary and that the parts be heated uniformly.
2. The principle of this method can be applied to diffusion bonding of other metals that form low-melting eutectics or solid solutions.
3. Inquiries concerning this innovation may be directed to:

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   Reference: B65-10370

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated by NASA.

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